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(54) Lift and propulsion installation of air-cushion transport vehicle

(57) A lift and propulsion installation of an air-cushion transport vehicle, comprises an annular duct 1 with an axial fan installed at the entrance portion thereof and with a thrust nozzle 4 disposed at the exit of the annular duct 1.

The thrust nozzle 4 has a reversing-and-steering device 5 with independently rotatable rudder blades 6, and reversing vanes 8 installed in the walls of the thrust nozzle 4. The side walls of the reversing-and-steering device 5 are made in the form of a polyhedral vaned surface, each facet of which is constituted by a fixedly secured cascade 7 of cambered reversing vanes 8, and the rudder blades which close the exit section of the thrust nozzle 4 during reversal of the thrust, make an obtuse angle γ whose apex 17 is directed toward the axial fan.

The invention may be used in the development of air-cushion transport vehicles, self-propelled transport platforms and apparatus, in which the translatory motion is effected due to a reactive thrust provided by the ejected air stream.

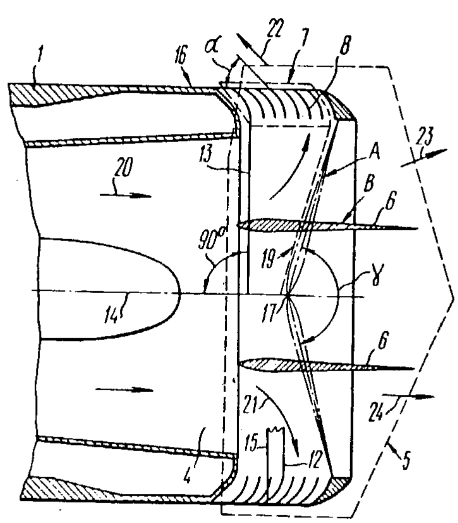

FIG.2

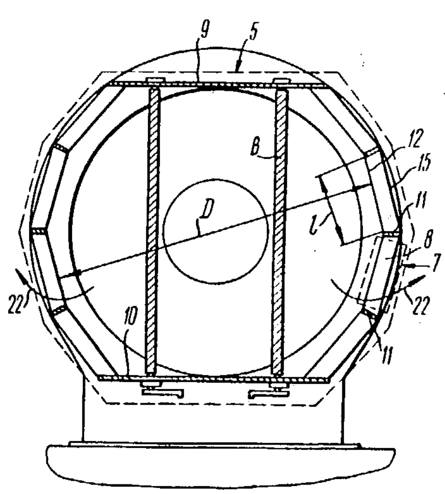

FIG.3

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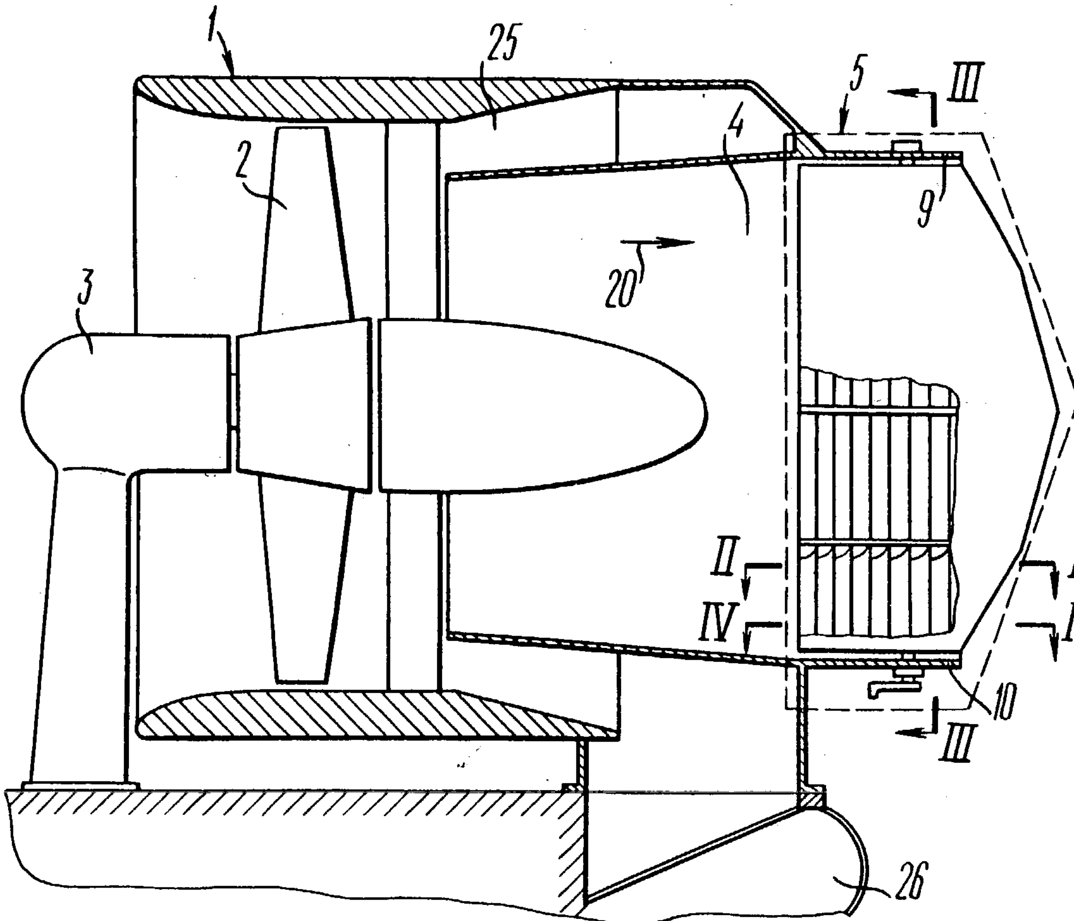

FIG.1

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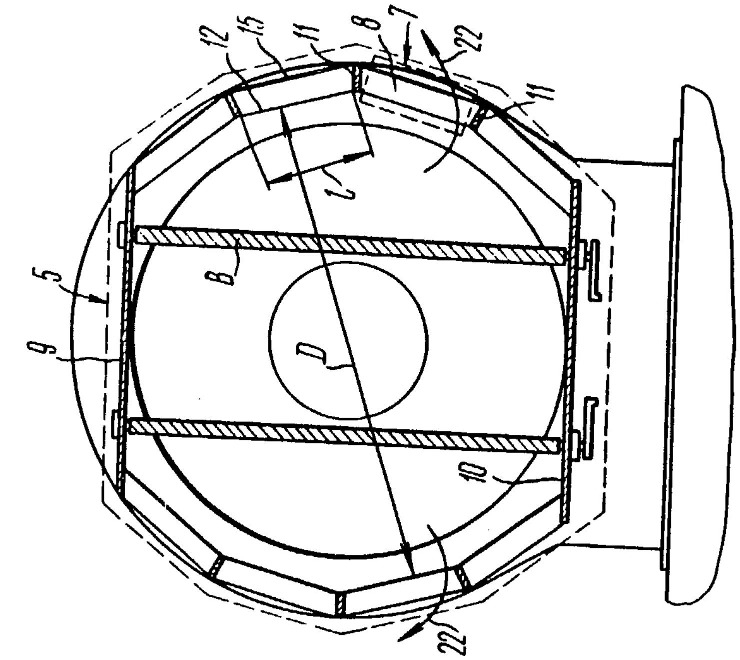

FIG.3

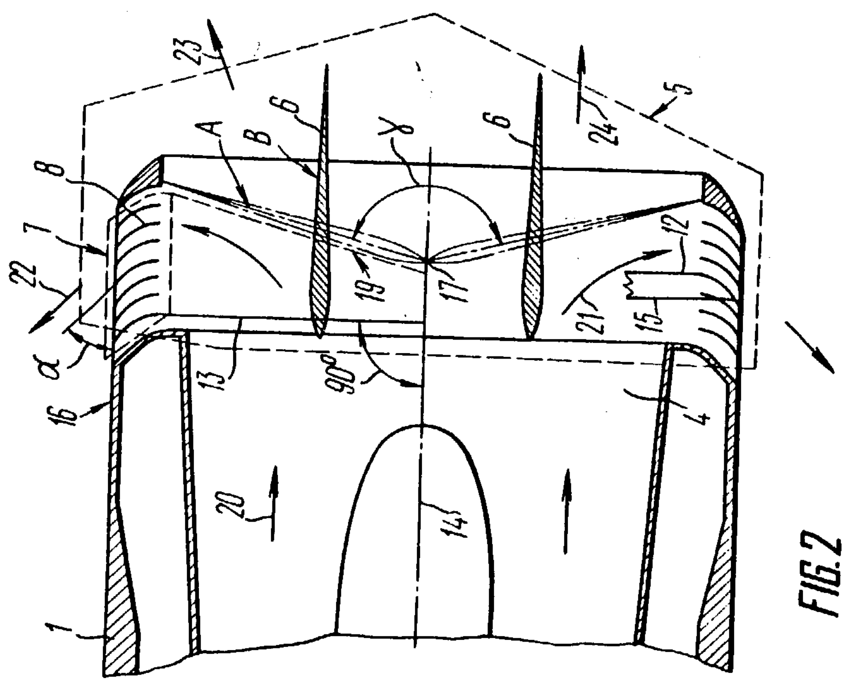

FIG.2

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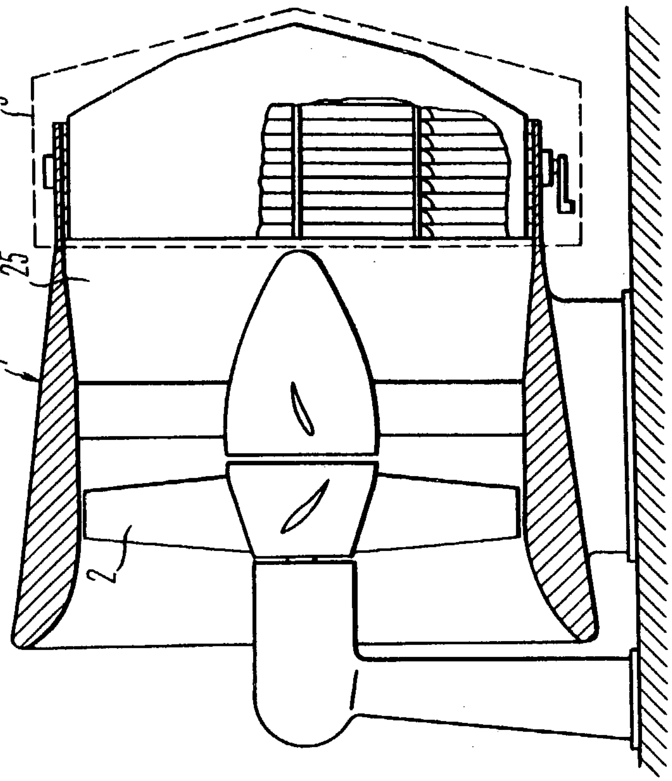

FIG.5

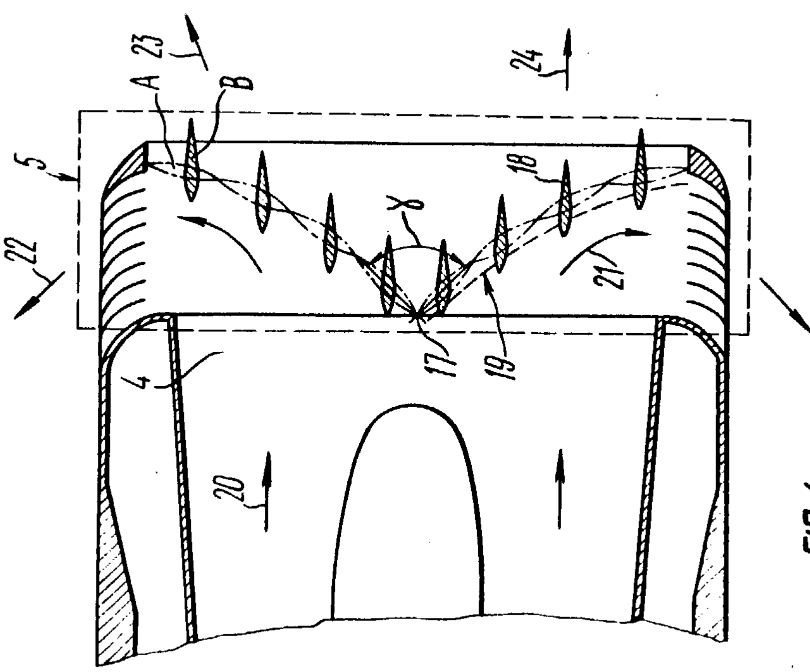

FIG.4

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SPECIFICATION

Lift and propulsion installation of air-cushion transport vehicle

The present invention relates to air-cushion transport vehicles and, more particularly, to lift and propulsion installations of an air-cushion transport vehicle.

The invention may be used in the development of air-cushion transport vehicles, self-propelled transport platforms and apparatus, wherein for supporting them above the bearing surface the use is made of a pressurized air delivered into a cushion, and the translatory motion is effected due to a reactive thrust provided by the ejected air stream. In such installations the pressurized air is delivered by fans. Directional control of the reactive thrust is effected by the use of a reversing-and-steering device installed at the exit of a reactive thrust nozzle or air passages.

The invention consists in that in a lift and propulsion installation of an air-cushion transport vehicle, comprising an annular duct provided at its entrance portion with an axial fan and at its exit, with a thrust nozzle having a reversing-and-steering device with independently rotatable rudder blades and reversing vanes installed in side walls of the thrust nozzle after the axial fan, the side walls of the reversing-and-steering device are made in the form of a polyhedral vaned surface, each facet of which is constituted by a cascade of bow-shaped reversing vanes, and the rudder blades close the exit section of the thrust nozzle during reversal of the thrust and make with each other an obtuse angle whose apex is directed toward the axial fan.

Leading edges of the bow-shaped reversing vanes may suitably be directed toward the rudder blades and kept perpendicular to a longitudinal axis of the fan, and trailing edges of the bow-shaped reversing vanes should be inclined at an acute angle to the side walls of the thrust nozzle and directed toward the entrance portion of the annular duct.

Such an arrangement of the bow-shaped reversing vanes makes it possible to install the latter almost along the entire perimeter in the facets of the nozzle side walls at the exit. This allows the axial length of the thrust nozzle portion provided with the bow-shaped reversing vanes, to be substantially reduced.

Besides, the cascades of the reversing vanes may be of the same standard sizes and the number of facets on the side walls may be selected, in this case, depending on the diametral sizes and the perimeter of the thrust nozzle side walls.

Arrangement of the rudder blades closing the exit section of the thrust nozzle during reversal, at which they make with each other the obtuse angle whose apex is directed toward the axial fan, makes it possible to turn and direct the air stream with minimum aerodynamic losses through the side walls of the reversing-and-steering device provided with the bow-shaped reversing vanes. This, in its turn, allows the amount and velocity of the reverse air stream to be increased with the result that the reverse thrust is augmented and the controllability of a transport vehicle is improved.

It is preferable that the rudder blades closing the exit section of the thrust nozzle be made up of at least two independently rotatable airfoils.

Such an embodiment of the rudder blades is convenient for a small-size nozzle, in which case the airfoils are of small sizes advantageous from the standpoint of technology and construction.

It will be appreciated that the rudder blades closing the exit section of the thrust nozzle during reversal, may be made up of a plurality of independently rotatable airfoils forming, in the closed position, surfaces for directing the air flow to the reversing vanes.

In this case the to-be-closed section of a thrust nozzle may be of substantial sizes, therefore from the standpoint of technology and construction, it will be advantageous instead of one broad airfoil to have a plurality of respectively narrower independently rotatable airfoils, with the total width thereof being approximately equal to the width of one broad airfoil.

Besides, a plurality of narrow airfoils may be installed inside the thrust nozzle so that at closing of the thrust nozzle the airfoils will form a smooth guiding curvilinear surface turning the air flow in reverse with small aerodynamic losses.

To enable the invention to be fully understood the embodiments thereof will now be described with reference to the accompanying drawings, wherein:

Fig. 1 schematically illustrates a vertical section of a lift and propulsion installation of an air-cushion transport vehicle, according to the invention;

Fig. 2 is a section taken on the line II—II of Fig. 1;

Fig. 3 is a section taken on the line III—III of Fig. 1;

Fig. 4 is a section taken on the line IV—IV of Fig. 1, illustrating an embodiment with a plurality of rudder blades, according to the invention;

Fig. 5 schematically illustrates a vertical section of a propulsion installation provided with a reversing-and-steering device.

A lift and propulsion installation of an air-cushion transport vehicle, according to the invention, comprises an annular duct 1 (Fig. 1) provided at its entrance portion with an axial fan having a wheel 2 rotated by a drive system 3. Disposed at the exit portion of the annular duct 1 is a thrust nozzle 4 incorporating a reversing-and-steering device 5 inside of which are installed independently rotatable vertical rudder blades made in the form of airfoils 6 (Figs. 2, 3), and side walls of the reversing-and-steering device 5 are formed by cascades 7 of bow-shaped vanes 8 which are fixedly secured between plane-parallel walls 9 and 10 (Fig. 3) and are mating with one another through the medium of plates 11, thereby making up a polyhedral vaned surface of the side

walls, through which air is ejected during reversal. In this case the number of facets of the side wall with the cascades 7 made up of the vanes 8 may be selected depending on a diametral size D between the cascades 7, with a preset constructional length l of the vanes 8.

The provision of the plane-parallel walls 9 and 10 makes it possible to ensure the sealing of tips of the airfoils 6 when the latter are turned to a closed position A (Fig. 2).

Such a constructional embodiment of the walls of the reversing-and-steering device allows almost the entire lateral surface to be utilized for ejection of the air flow during reversal, due to which the reverse thrust is augmented and the axial length of the reversing-and-steering device may be reduced. In addition, it is convenient from the standpoint of technology, to have only one standard cascade 7 (Fig. 3) made up of the simple vanes 8 which are comparatively small in size, have the length l and are bow-shaped in the cross-section. Such a solution permits a type-size series of the reversing-and-steering devices to be completed with the same cascades 7 differing only by the diametral size D. In this case, it is sufficient to set up a required number of facets in the side walls of the reversing-and-steering devices.

To ensure the turning of air flow during reversal with minimum aerodynamic losses, each bow-shaped vane 8 by its leading edge 12 (Figs. 2, 3), in an optimum variant, is turned toward the airfoils 6 and lies in a plane 13 (Fig. 2) perpendicular to a longitudinal axis 14 of the fan. This ensures a shock-free entry of the air flow to the vanes 8 during reversal.

Trailing edges 15 of the vanes 8 are inclined at an acute angle α to an external surface 16 of the annular duct 1 and directed toward the entrance portion thereof, due to which the air stream having passed during reversal through the cascade 7, flows toward the trailing edges 15, thereby producing the reverse reactive thrust. The airfoils 6 in the closed position A, i.e. at closing the exit section of the thrust nozzle 4 and during the thrust reversal, make with each other an obtuse angle γ. In this case, an apex 17 of the angle γ made by the airfoils 6, is directed toward the wheel 2 of the axial fan. This creates favourable conditions for the flow of air stream passing to the airfoils 6 when the reversing air stream is turned toward the bow-shaped vanes 8.

According to the invention, the rudder blades may also be made up of a plurality of independently rotatable airfoils 18 (Fig. 4) of reduced width when compared with the airfoils 6 (Fig. 2), which on closing the exit section of the thrust nozzle 4 (Fig. 4) form, in the closed position, a guiding surface 19 for ejection of the air stream during reversal of the reactive thrust.

The lift and propulsion installation of an air-cushion transport vehicle, with the reversing-and-steering device operates in the following way.

The drive system 3 (Fig. 1) rotates the wheel 2 of the axial fan due to which air is drawn into the annular duct 1 and passes in a direction 20 (Figs. 1, 2) toward the thrust nozzle 4, flows past the airfoils 6 of the rudder blades turned to an open position B, and is ejected from the thrust nozzle 4 outside in the direction of the longitudinal axis 14, thereby producing the reactive thrust imparting the translatory motion to a transport vehicle.

When it is necessary to reverse a reactive thrust, the airfoils 6 and 18 of the rudder blades are turned to the closed position A (Figs. 2 and 4). As a result, the air stream passes to the thrust nozzle 4 in the direction 20 and then flows along the guiding surface 19 in a direction 21, passes through the cascade 7 of the bow-shaped vanes 8, wherein the air stream is diverted toward the entrance portion of the annular duct and is ejected outside in a direction 22, thereby producing the reactive thrust moving the transport vehicle in reverse.

For maneuvering and making turns of a transport vehicle, one of the airfoils 6 (Fig. 2) of the rudder blades is set to an intermediate position between the positions A and B, due to which the air stream being thus turned in a direction 23 is ejected from that side to which the transport vehicle is to be turned, while the airfoil 6 located at the opposite side of the longitudinal axis 14 remains in the open position B and the air stream is ejected without any diversion in a direction 24. Such a position of the airfoils 6 sets up a moment of reactive forces from the air streams ejected in the directions 23 and 24 with the result that the transport vehicle is turned.

However, in a number of cases and particularly on air-cushion vehicles of high load-carrying capacity, the use is made of individual, self-contained lift and propulsion installations. In this case a self-contained propulsion installation may be provided with the reversing-and-steering device heretofore described.

A modified embodiment of the propulsion installation with the reversing-and-steering device will now be considered as applied to this case.

In a self-contained propulsion installation of an air-cushion transport vehicle, the entire air stream delivered by the wheel 2 (Fig. 5) installed in the annular duct 1, flows into a thrust nozzle 25 and then passes through the reversing-and-steering device 5. Owing to the fact that the entire air stream passes through the thrust nozzle 25, the reactive thrust produced by the self-contained propulsion installation is increased.

In other respects related to the directional control and reversal of the reactive thrust, the self-contained propulsion installation with the reversing-and-steering device 5 will operate in the same way as the above described lift and propulsion installation of an air-cushion transport vehicle of Fig. 1.

Thus, the disclosed embodiments of the lift and propulsion installation of Fig. 1 and the propulsion installation of Fig. 5, comprising respectively the thrust nozzles 4 and 25 provided with the reversing-and-steering device 5, ensure the effective directional control of an air-cushion

transport vehicle. The axial size of the reversing-and-steering device 5 may be minimized and the control thereof will be simplified, as for an effective all-round maneuverability and directional control to be accomplished through the medium of such a reversing-and-steering device, it is sufficient to provide only an independent turning of the rudder airfoils 6 or 18 (Figs. 2, 4).

Claims

1. A lift and propulsion installation of an air-cushion transport vehicle, with an axial fan installed at the entrance portion of an annular duct; positioned at the exit of said annular duct is a thrust nozzle provided with a reversing-and-steering device with independently rotatable rudder blades and reversing vanes installed in side walls of the thrust nozzle after said axial fan; said rudder blades close the exit section of said thrust nozzle during reversal of the thrust and make with each other an obtuse angle whose apex is directed toward said axial fan, and the side walls of said reversing-and-steering device are made in the form of a polyhedral vaned surface, each facet of the side wall being constituted by a cascade of bow-shaped reversing vanes.

2. A lift and propulsion installation of an air-cushion transport vehicle according to Claim 1, in which leading edges of said bow, shaped reversing vanes are directed toward said rudder blades and kept perpendicular to a longitudinal axis of said axial fan, and trailing edges thereof are inclined at an acute angle to the side walls of said thrust nozzle and directed toward the entrance portion of said annular duct.

3. A lift and propulsion installation of an air-cushion transport vehicle according to Claims 1, 2, in which said rudder blades are formed by at least two streamlined airfoils.

4. A lift and propulsion installation of an air-cushion transport vehicle according to Claims 1, 2, in which said rudder blades are formed by a plurality of streamlined airfoils making up, in the closed position, guiding surfaces which close the exit section of said thrust nozzle.

5. A lift and propulsion installation of an air-cushion transport vehicle substantially as herein described with reference to and as illustrated in the accompanying drawings.

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